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BUREAU OF WILDLIFE MANAGEMENT
RESEARCH DIVISION
PROJECT ANNUAL JOB REPORT

PROJECT CODE NO.: 05011

TITLE: Conservation Reserve Enhancement Program Administration and Monitoring

JOB CODE NO.: 01004A

TITLE: Effects of Local and Landscape Features on Avian Use and Productivity in Conservation Reserve Enhancement Program (CREP) Fields

PERIOD COVERED: 1 July 2002 to 30 June 2003

COOPERATING AGENCIES: Pennsylvania Game Commission and Pennsylvania State University School of Forest Resources

WORK LOCATIONS: Montour, Columbia, Berks, Schuylkill, Union, Northumberland, and Snyder Counties

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DATE: 30 July 2003

Abstract: In North America, grassland birds have declined more than any other group of birds over the last 25 years. In 2001, a federal program, the Conservation Reserve Enhancement Program (CREP), was initiated in 20 counties in southeast Pennsylvania to address problems with soil erosion and to provide habitat for grassland and farmland birds. This program provides financial support to farmers to take fields out of production. By 2002, 40,460 ha were enrolled in PA. The objectives of this study were to determine how avian abundance, diversity, and productivity within CREP fields varied with characteristics of the field (e.g. size and vegetation) and the local landscape; and to compare CREP field use and success with hayfields. In Berks, Montour, Northumberland, Schuylkill, Snyder, and Union counties CREP fields were selected randomly in 3 size categories: 2.0–4.0 ha (small), 7.3–12 ha (medium), and 16–28 ha (large). We also located hayfields near the CREP fields. We surveyed birds in all fields and nest-searched in a sub-sample of fields. In 2001 and 2002, we monitored 555 nests of 17 species in 44 fields within 3 counties (Montour, Snyder, and Union). Nest density and success did not differ with field size. Birds nesting in CREP fields had a higher nest success rate than those nesting in hayfields. Obligate grassland species (those that require grassland habitat) nested more frequently on large than medium or small fields. There were no effects of local landscape factors (edges) on the success of different species. Characteristics of the landscape (% forest, perennial, and annual herbaceous cover) surrounding the field were not correlated with nest density or success. Data was collected in 2003, but has not been analyzed to date. The final field season is 2004. The final report will be prepared by 1 July 2005.

OBJECTIVES

1. To determine the effects of CREP on abundance, distribution, and productivity of grassland birds.

2. To determine how use of and productivity within warm-season and cool-season fields vary with field size, age, and adjacent landscape.

3. To determine differences between the use and productivity of CREP fields and hayfields by grassland birds.

4. To develop management guidelines for maximizing benefits of CREP for grassland birds.

METHODS

See Appendix 1 for a description of methods used.

RESULTS

See Appendix 1 for a summary of the results from the 2001 and 2002 seasons. Data has not been analyzed for the 2003 season.

Appendix 1. Progress report of avian monitoring on CREP fields.

Effects of local and landscape features on avian use and productivity in Conservation Reserve Enhancement Program fields

Progress Report (July 2001 – May 2003)

The Pennsylvania Game Commission

Cooperative Agreement ME231002

May 2003

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EFFECTS OF LOCAL AND LANDSCAPE FEATURES ON AVIAN USE AND PRODUCTIVITY IN CONSERVATION RESERVE ENHANCEMENT PROGRAM FIELDS

Abstract

In North America, grassland birds have declined more than any other group of birds over the last 25 years. In 2001, a federal program, the Conservation Reserve Enhancement Program (CREP), was initiated in 20 counties in southeast Pennsylvania to address problems with soil erosion and to provide habitat for grassland and farmland birds. This program provides financial support to farmers to take fields out of production. By 2002, 40,460 ha were enrolled in PA. The objectives of my study were to determine how avian abundance, diversity, and productivity within CREP fields varied with characteristics of the field (e.g. size and vegetation) and the local landscape; and to compare CREP field use and success with hayfields. In Berks, Montour, Northumberland, Schuylkill, Snyder and Union counties CREP fields were selected randomly in three size categories: 2.0 – 4.0 ha (small), 7.3 – 12 ha (medium), and 16 – 28 ha (large). I also located hayfields near the CREP fields. I surveyed birds in all fields and nest searched in a sub-sample of fields. In 2001 and 2002, I monitored 555 nests of 17 species in 44 fields within 3 counties (Montour, Snyder and Union). Nest density and success did not differ with field size. Birds nesting in CREP fields had a higher nest success rate than those nesting in hayfields. Obligate grassland species (those that require grassland habitat) nested more frequently on large than medium or small fields. There were no effects of local landscape factors (edges) on the success of different species. Characteristics of the landscape (%forest, perennial and annual herbaceous cover) surrounding the field were not correlated with nest density or success. My study has shown that nest success is higher on CREP fields than hayfields. Within CREP fields, nest density and success did not differ with field size but larger fields supported more species and more obligate grassland species.

Introduction

Grassland birds have experienced widespread declines throughout the Midwest and Eastern United States (Robbins et al. 1986, Bollinger and Gavin 1992, Askins 1993). Furthermore, grassland birds have declined more than any other group of birds over the last 25 years (Knopf 1994, Herkert 1995). In Pennsylvania, species such as the Grasshopper Sparrow (scientific names given in Appendix 1), Vesper Sparrow, Bobolink, Eastern Meadowlark, Northern Bobwhite, and Ring-necked Pheasant have declined by 80% or more since the mid 1960's (Sauer et al. 2001). Declines have been attributed to habitat loss and changes on both the breeding grounds (Samson and Knopf 1994) and the wintering grounds (Fretwell 1986). In Pennsylvania, loss of habitat for these species has occurred because of farmland conversion and changes in farming practices.

The Conservation Reserve Enhancement Program (CREP) is a federally-funded program of the United States Department of Agriculture (USDA) that offers farmers the opportunity to take highly erodible and environmentally sensitive land out of production, thereby improving water quality, reducing soil erosion and increasing grassland, wetland and riparian habitat for wildlife (www.fsa.usda.gov/dafp/cepd/crepqnas.htm). The program provides significant increases in the rental rate farmers are currently offered through the Conservation Reserve

Program (CRP), making it more economically feasible for them to participate. Such a program is greatly needed to restore wildlife habitat, particularly that of small game and grassland-nesting birds. Twenty Pennsylvania counties within the Chesapeake Bay Watershed (a national priority area for recovery) have been identified for enrollment. Within these counties there are 22,685 farms comprising 1,201,662 ha (2,970,000 acres) of farmland, 931,794 ha (2,303,000 acres) of which are cropland. Of the cropland, 288,075 ha (712,000 acres) are considered highly erodible land, which should be idled (Tosiano and Capstick 1999). The goal of the CREP Program is to enroll at least 40,460 ha (100,000 acres) in the Pennsylvania program (www.dep.state.pa.us/dep/deputate/polycomm/update/05-26-00/052600u7).

Enrollment of 40,460 ha (100,000 acres) of farmland in Pennsylvania has the potential to greatly benefit grassland-nesting birds, such as the Ring-necked Pheasant and Grasshopper Sparrow. However, to maximize program benefits, managers need to know how avian use and productivity varies with field size and vegetative structure (density; height; and percent composition of grass [warm or cool-season], forb, and woody vegetation). It is also important to understand if the immediate surroundings (e.g. wooded or agricultural edge) impact productivity and use.

From work in both forest and grassland habitats, we know that avian use and productivity vary with both local and landscape features (Askins 1993, McGarigal and McComb 1995, Donovan et al. 1997). For example, numerous grassland species including the Vesper Sparrow, Grasshopper Sparrow, and Bobolink are considered to be area-sensitive and do not occur in fields below a minimum size (Askins 1993). However, this minimum size is variable depending on location (e.g. Herkert 1994, Vickery et al. 1994, Bollinger 1995, Winter and Faaborg 1998, Horn 2000), with the majority of work done in the Midwest where the landscape is primarily open habitat. Consequently, it is important to understand how grassland species react in a primarily forested state such as Pennsylvania. Studies in the Midwest have been conducted to look at the effects of CRP practices on wildlife (e.g. King and Savidge 1995, Best et al. 1997, Horn 2000), but these studies may not be directly applicable to the Eastern United States where the landscape matrix is primarily forest and field size is smaller. King and Savidge (1995) examined fields that ranged from 40-80 ha; Best et al. (1997) had an average field size that ranged from 11.5 ha in MI to 39.1 ha in IA; and Horn (2000) examined fields with a median size in different landscapes of 28 and 27 ha in ND, 15 and 26 in IA. In Pennsylvania, the largest fields available in CREP are approximately 42 ha and the mean is 8.1 ha (Scott Klinger pers. comm.). Predation is higher on nests near a forested edge (Johnson and Temple 1990), which may indicate higher predation in a landscape dominated by forest. In addition, there is evidence that productivity for ring-necked pheasants and other grassland birds, a better measurement of habitat quality, is also dependent on habitat patch size and the vegetative cover (e.g. Johnson and Temple 1990, Horn 2000, McCoy et al. 2001).

Our objectives were to (1) determine the abundance, distribution, and productivity of grassland birds on CREP fields; (2) determine how field size affects use and productivity of grassland birds; (3) determine if there is a difference in use and productivity between CREP fields and hayfields; (4) determine what vegetation characteristics affect the use and productivity of grassland birds, especially the use of warm-season and cool-season grasses, since these are the two dominant plantings within CREP fields.

Methods

Our study is designed to test the effects of local and landscape factors on bird use and reproductive success in CREP and hayfields. Fieldwork was conducted in the summers of 2001 and 2002. The summer of 2001 was a pilot study and methods were then modified for 2002.

Pilot study - 2001

In 2001, we conducted a pilot study in Montour County. This county had available fields in the Montour Preserve, in addition to CRP fields and CREP fields that already had established cover (CRP roll-overs). We randomly selected 4 fields, from the available fields mentioned above, (2 warm-season and 2 cool-season grass dominated fields) in 3 size categories: 2.0 – 4.0 ha (small), 8.0 – 12 ha (medium), and 16 – 28 ha (large). We also attempted to locate 2 hayfields in each of the size categories. We located 2 small and 2 medium sized hayfields in each of the size categories but were only able to locate one hayfield in the large category, due to a lack of larger hayfields near the CREP fields.

Avian abundance and reproductive success - To examine productivity we located active nests by walking through the entire field every 3-4 days watching female and male actions and scanning the vegetation. Nests were marked using colored flagging 10 m to the north of the nest. Active nests were monitored as the fields were searched to determine success (fledging of at least one young) or cause of failure (either abandonment, the loss of all eggs or nestlings).

We surveyed birds within each study field using 100 m transects (25m on each side of the transect; Best et al 1997). Transects were located ≥ 50m from an edge (when possible) and located no closer than 50m from each other. We established as many transects as possible within the field that meet the above criteria (Best et al. 1997). We surveyed each field twice the first between 5/28 – 6/5 and the second between 6/28 – 7/5 to detect early breeders and to detect Neotropical migrants, which tend to breed later. The surveys were conducted from sunrise to 3 hours after sunrise, and were not conducted when it was raining or winds were greater than 16 kph (Best et al. 1997).

Local habitat Characteristics - We measured local habitat structure including density (Robel et al. 1970), height of grass, depth of litter and amount of vegetative cover (i.e. percent cover of warm or cool-season grass, ground litter, standing litter [dead stems that are still standing], woody vegetation, forb and bare ground: Daubenmire 1959). These were conducted at each nest and 3m away from the nest in the four cardinal directions after the termination of nesting activity. Each field was sampled using six equally spaced points along the already established transects for the bird surveys (McCoy et al. 2001). We trained all field assistants on how to measure the different vegetation characteristics and the amount of vegetative cover, litter depth and vegetation density were collected at each sample point. Field vegetation sampling took place concurrent with the bird surveys. We also recorded the distance of each nest from edges (e.g. tree lines, agriculture, and roads) using laser range finders (accurate at ± 0.3m at 1000m) to help identify any relationships with productivity and use of the fields by different species.

Field Season - 2002

Field Selection - In 2002, we separated the 20 counties in CREP into 3 categories by % forest cover within the county (to select for landscape differences): 19 – 45% (low), 46 – 60% (medium), and 61 – 74% (high) as calculated from the GAP analysis of Pennsylvania (Bishop

1998). We then randomly selected 6 counties (2 from each level of forest cover) from this group, we randomly selected 3 counties (one from each forest cover category) to be both surveyed and nest searched. The other 3 counties were only surveyed. In all 6 counties we randomly selected 3 fields in each of the 3 size categories. Fields were selected from all CREP fields available that had been planted for more than a year. We also attempted to find two medium sized hayfields in each county. We reduced the number of hayfields from the pilot study because of the manpower needed to cover all the fields in a county. We eliminated the small size category because in 2001 the small hayfields had only one nest combined. We eliminated the large category because of low availability. Although we attempted to locate 2 hayfields per county, we were only able to locate one medium sized hayfield in each county for similar reasons to 2001.

Avian Abundance and Reproductive Success - In 2002, two individuals surveyed birds on all fields. In order to correct for different detection probabilities between the two individuals and among different species we surveyed each field using distance-sampling techniques (Emlen 1971, 1977 and Buckland et al. 2001). Transects were established 100m from an edge and then every 250m until the field was covered. The final transect was at least 50m from the farthest edge. Each field was surveyed twice, the first between 5/25 – 6/7 and the second between 6/25 – 7/7 to detect early breeders and to detect Neotropical migrants, who tend to breed later. Surveys were conducted from sunrise to 3 hours after sunrise, and were not conducted when it was raining, foggy or the winds were greater than 16 kph (Best et al. 1997). Using PROGRAM DISTANCE 3.5 (Thomas et al. 1998), we calculated the density of each species of bird, with at least 40 observations, in each field using observer and species detection functions.

We located and monitored nests as described under the pilot study. In addition, two infrared remote video cameras (Fuhrman Diversified, Inc.) were used to attempt to identify what was predating nests. We placed cameras on 6 nests, 5 Red-winged Blackbirds and a Dickcissel. The cameras were placed on nests that were in later stages of incubation to minimize abandonment (pers. obs.). Because of the short focal length of the camera, they must be placed within 0.5 m of the nest (usually closer because of obstructions hiding the nest). The power source (a 12 volt deep cycle marine battery) and VHS time-lapse recorder were placed 22m from the camera. There was little disturbance to the nest when changing the battery and tape (every two days). We were also able to check the nest from the battery station with a remote viewer so that the contents could be checked without disturbing the nest any more than a "regular" nest. The cameras were left on the nest until the nest either succeeded or failed. Nests were chosen at random as a camera became available (nest success or failure) and more than one nest of the species was present in the field (except for the Dickcissel).

Local habitat Characteristics – we used the same methods as described for the pilot study.

Landscape Level Analysis - Land cover characteristics (e.g. forest cover, open cover and residential cover) were calculated from the GAP analysis of PA (Bishop 1998). Radii were established around each field (0.5 km, 1 km, 2 km, and 5 km) in order to determine the percentage of cover surrounding each field. These data were then be used to evaluate any effect on the use and productivity of grassland birds.

Data Analysis - We used the Kolmogorov-Smirnov test of normality on all data to determine if the data were normally distributed. We analyzed nest success using the Mayfield Method (Mayfield 1961 and 1975) and PROGRAM CONTRAST (calculated Mayfield success and SE) by comparing between field size categories and between CREP fields and hayfields. Because many of the fields did not have any nests or few nests in which to calculate nest success, we also analyzed nest success as the number of successful nests/ha. We performed linear regressions between field size and nest density (the number of nests/ha) and nest success/ha. To compare CREP and hayfield nest success and nest density, we used a Mann-Whitney Test. Linear regression was used to identify if there was a relationship between the density of a species (from survey results) and the number of nests found in the field.

To determine if field size affects species diversity we performed a linear regression with the number of species nesting in the field as the response variable and field size as dependent variable. We examined the relationship between field size and the presence/absence of any grassland obligate species (from nesting and survey data) using a logistic regression. To compare the presence/absence of any obligate grassland species from hayfields and CREP fields a Fisher Exact Test was used because a Chi-square was inappropriate (expected values for hayfields were <5).

We used a Pearson correlation to compare the vegetation variables to determine independence. In order to create independent variables, Principal Component Analysis (PCA) was used. These variables were used in regressions to analyze which variables affected nest success for individual species. PC variables were chosen with eigen values ≥ 1.0 (unless the cumulative proportion was still less than 0.80). We used these PC variables in a binary logistic regression and re-ran the regression excluding the variable with the highest p-value until there was a single variable or the regression was significant ($p \leq 0.05$).

We used logistic regression to compare successful and unsuccessful nests and their distance to an edge (i.e. road, tree line, woodlot and cropland) for individual species in which we had measurements for >4 nests.

We used percent forest, annual herbaceous and perennial herbaceous (we added transitional cover to this category because this is perennial herbaceous with additional low shrubs) cover from the 4 different radii as the variables when examining landscape factors. We used stepwise linear regression, $p = 0.15$ to enter or leave the regression, to analyze the affect of landscape variables on the nest density, and nest success.

MINITAB[tm] (MINITAB, Inc.) was used to calculate all statistics, except Fisher Exact Test which was calculated using Excel (Microsoft, Inc.). All means are reported $\pm$ one Standard Error.

Results

Species Use - We located 555 nests over the 2001 and 2002 breeding seasons on 44 fields (Appendix 2) in three different counties. Large fields had 13 species (mean $3.82 + 0.59$), medium fields had 10 species (mean $2.23 + 0.40$) and small fields had 9 species (mean $1.23 + 0.41$) nesting on them. There was a linear relationship with the number of species nesting on a field and the field size (num of species = 0.664 + 0.153 size; $t = 4.49$, $p = 0.000$; Fig. 1). CREP fields (mean $2.35 + 0.31$) had significantly more species nesting per field than hayfields (mean $0.86 + 0.34$) when using field size as a covariate ($F = 4.90$, $df = 1$, $p = 0.032$). There was not a significant relationship between the presence of at least one obligate (located during surveying)

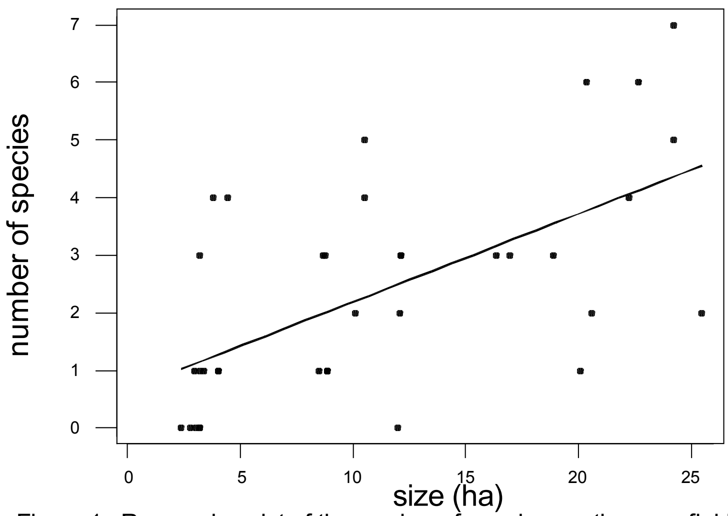

Figure 1. Regression plot of the number of species nesting on a field and the size of the field (ha). Regression equation is: num of species = 0.665 + 0.153 size, adj R2 = 34.8%.

grassland bird_

and CREP field categories ($X^2 = 4.22$, df = 2, $p = 0.121$; Table 1) or CREP and hayfields (Fisher Exact test, $p > 0.32$; Table 2). Significantly more large fields had at least one grassland obligate species (Bobolink, Dickcissel, Eastern Meadowlark, Grasshopper

Sparrow, Mallard, Ring-necked Pheasant, Savannah Sparrow, Vesper Sparrow) nesting on them than expected when comparing between field size categories ($X^2 = 8.451$, DF = 2, p = 0.015; Table 3). However, there was not a significant difference between CREP fields and hayfields using the Fisher Exact Test (p = 0.36; Table 4). This is probably a result of low numbers of hayfields since there was only one hayfield with a Bobolink nest on it.

Table 1. Presence or absence of obligate grassland species on the three different field size categories located during surveys in Southeast Pennsylvania during the summer of 2001 and 2002. Expected values are in parenthesis.

	large	medium	Small	All
Present	12 (8.4)	10 (11.7)	6 (7.9)	28
Absent	6 (9.6)	15 (13.3)	11 (9.6)	32
All	18	25	17	60

Table 2. Presence or absence of obligate grassland species on CREP and hayfields located during surveys in Southeast Pennsylvania during the summer of 2001 and 2002. Expected values are in parenthesis.

	CREP	hay	All
Present	25 (25.2)	3 (2.8)	28
Absent	29 (28.8)	3 (3.2)	32
all	54	6	60

Bird Density - There was no relationship between field size and bird density, for any of the species for which densities were calculated (Bobolink, Red-winged Blackbird, Field Sparrow, Grasshopper Sparrow, or Song Sparrow; see Appendix 3 for regression equations and regression plots). The density of Field Sparrow, Grasshopper Sparrows, and Song Sparrows was significantly higher in CREP fields than hayfields, but there was not a significant difference in Bobolink or Red-winged Blackbirds (Table 5). There was

Table 3. Chi-square test comparing the presence or absence of grassland species (BOBO, DICK, EAME, GRSP, MALL, RNPH, SAVS, VESP) nesting in fields by size category (large, medium, small) in Southeast Pennsylvania during the summers of 2001 and 2002. Expected values are in parenthesis.

	Large	Medium	Small	All
Present	8 (4.0)	4 (6.6)	4 (5.5)	16
Absent	3 (7.0)	14 (11.5)	11 (9.6)	28
All	11	18	15	44

Table 4. Chi-square test comparing the presence or absence of grassland species (BOBO, DICK, EAME, GRSP, MALL, RNPH, SAVS, VESP) nesting in CREP fields and hayfields in Southeast PA during the summers of 2001 and 2002. Expected values are in parenthesis.

	CREP	Hay	All
Present	15 (13.5)	1 (2.5)	16
Absent	22 (23.5)	6 (4.5)	28
All	37	7	44

Table 5. Density (birds/ha) calculated using distance sampling for different species found on CREP and hayfields during the summer of 2002.

Species	CREP (N = 54)	Hayfield	T value	p value
BOBO	0.03 + 0.03	0.17 + 0.09	-1.49	0.186
RWBL	0.60 + 0.10	1.03 + 0.65	-0.65	0.543
FISP*	0.12 + 0.03	0	4.26	0.000
GRSP	0.10 + 0.03	0.02 + 0.02	2.14	0.042
SOSP*	0.26 + 0.05	0	5.47	0.000

*There were no birds located on hayfields so a one-tailed t-test was performed against a mean of 0.

a significant relationship between bird density and the number of that species nests on the field (Table 6).

Table 6. Linear regression of the number of singing males located during surveying and the number of nests located in the same fields in Southeast Pennsylvania in the summer of 2002.

Species	Regression line	Adj R^2	p value
FISP	nests = - 0.28 + 1.11 density	41.0	0.004**
GRSP	nests = - 0.810 + 0.500 density	91.4	0.000***
RWBL	nests = - 1.27 + 0.719 density	68.0	0.000***
SOSP	nests = - 0.27 + 0.422 density	22.9	0.026*

Nest Density - There was not a significant difference in nest density between CREP and hayfields (W = 873, p = 0.197). Because there was no significant difference, we then used all fields in further analysis. There was no significant difference in nest density between any of the size categories of fields (H = 2.32, df = 2, p = 0.314). There was no relationship between nest density and the actual field size (nests/ha = 0.723 + 0.0110 SIZE; F = 0.29, R^2 = 0.00, p = 0.593).

To look at larger landscape characteristics each species nest density/ha was compared with the percent of landscape cover (forest, perennial herbaceous [with transitional cover included], and annual herbaceous) surrounding the field in radii of 0.5, 1.0, 2.0, 5.0 km (see appendix 5). Field Sparrows showed no relationship to any of the cover types or radii. Red-winged Blackbirds showed a significant relationship with forest cover (nests/ha = 0.7504 - 0.0299 forest 0.5km + 0.021 forest 1.0km; adj. R^2 = 11.14). Song Sparrow showed a relationship with annual herbaceous (nests/ha = 0.0770 - 0.00146 annual 2.0km; adj. R^2 = 7.27). Grasshopper Sparrows showed a trend with perennial herbaceous 5.0 km (nests/ha = - 0.0286 + 0.00277 Perennial 5.0km; adj. R^2 = 5.61).

Nest Success - The overall nest success for passerine birds was 26.4% (using the Mayfield Method on all nests; see Table 7 for individual species). The use of PROGRAM CONTRAST showed no difference in nest success between the CREP

Table 7. Mayfield Success Rate for individual species, with at least 6 nests, calculated using exposure days for all nests within a species for the 2001 and 2002 breeding seasons in selected fields in Southeast Pennsylvania.

Species	Number of nests used in calculation	Mayfield Success Rate
EAME	6	21.5
FISP	117	28.4
GRSP	16	15.6
INBU	7	20.4
MALL	7	10.0
RWBL	301	27.4
SOSP	37	34.4
WITU	11	18.1

field size categories (Table 8), but CREP fields had significantly higher nest success than hayfields (Table 8). There was not a linear relationship between nest success/ha and field size (Fig. 1).

Table 8. PROGRAM CONTRAST results when comparing Mayfield nest success rates, by field (with at least 5 passerine nests), between three CREP field size categories and hayfields in Southeast Pennsylvannia for the summers of 2001 and 2002.

Comparison	X^2 value	df	P value
Large – medium – small – hay	14.07	3	0.003**
Large – medium – small	0.16	2	0.925
CREP – Hay	10.24	1	0.014*

For individual species, we examined the effect of vegetation on nest success. Because the vegetation characteristics were correlated (see Appendix 4), Principle Component Analysis was used to create independent variables that were then used in

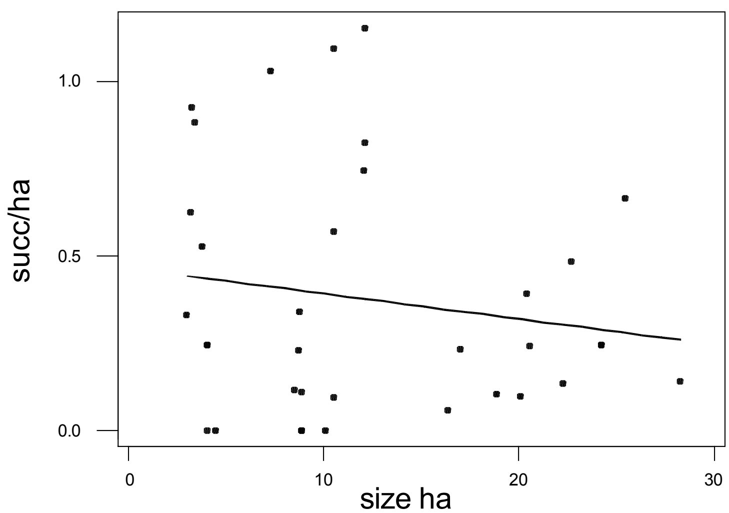

Figure 1. Regression plot for successful nests/ha and field size. The regression equation is: succ/ha = 0.465282 - 0.0072446 SIZE; adj. R2 = 0.0%

binary logistic regressions. Field Sparrow PC 1,2,3, and 5 were included in the final regression (G = 11.564, df = 4, p = 0.021; Table 9), which indicates that there is a relationship between these 4 vegetation variables and nest success. Field Sparrow nests were more successful with a thinner litter depth, more standing litter, taller and higher vegetative density. Grasshopper Sparrow PC 1 was included in the final regression, but there was no significant relationship with this vegetation variable and the success of the nest (G = 1.202, df = 1, p = 0.273). Red-winged Blackbird PC 1,2,3,4,5 and 6 were included in the final regression (G = 18.877, df = 6, p = 0.004; Table 10). Red-winged Blackbird nests that were more successful had more coverage in cool-season grass and

Table 9. Principal Component Analysis for vegetation characteristics of successful and unsuccessful FISP nests in Southeast Pennsylvania for the summers of 2001 and 2002.

Variable	PC	PC[a] value	Successful	Unsuccessful
Bottom	1	0.479	17.4 $\pm$ 2.2	13.4 $\pm$ 2.3
veg heig	1	0.476	82.1 $\pm$ 5.1	82.7 $\pm$ 4.5
rob 3m	1	0.459	55.8 $\pm$ 3.1	52.4 $\pm$ 2.4
c-g	2	0.617	11.9 $\pm$ 2.4	9.5 $\pm$ 1.9
d lit	3	0.574	15.2 $\pm$ 1.5	19.1$\pm$ 1.5
litter d	5	0.552	2.2 $\pm$ 0.2	2.1 $\pm$ 0.2
s lit	5	0.452	6.28 $\pm$ 1.6	3.3 $\pm$ 0.5

[a] Only variables with a PC value $\geq$ 0.45 are shown

Table 10. Principal Component Analysis for vegetation characteristics of successful and unsuccessful RWBL nests in Southeast Pennsylvania for the summers of 2001 and 2002.

Variable	PC	PC[a] value	Successful	Unsuccessful
Bottom	1	0.549	26.7 $\pm$ 1.8	28.0 $\pm$ 1.2
Veg height	1	0.517	101.3 $\pm$ 3.0	91.9 $\pm$ 1.1
Forb	2	0.558	49.5 $\pm$ 2.51	45.0 $\pm$ 2.0
d lit	2	0.452	8.2 $\pm$ 0.7	12.0 $\pm$ 0.8
c-g	3	0.668	34.5 $\pm$ 2.4	33.5 $\pm$ 1.9
rob 3m	4	0.453	66.9 $\pm$ 2.3	61.3 $\pm$ 1.4
w-g	4	0.551	1.3 $\pm$ 0.9	1.6 $\pm$ 0.6
Ave conc	5	0.653	69.5 $\pm$ 2.6	67.7 $\pm$ 1.7
Ave s-lit	6	0.825	2.6 $\pm$ 0.6	2.5 $\pm$ 0.3

[a] Only variables with a PC value $\geq$ 0.45 are shown

litter, deeper litter cover, less coverage in warm-season grass, and forbs, also less vegetative density. Song Sparrow PC 4 was included in the final regression, which was not significant ($G = 2.882$, $df = 1$, $p = 0.090$), indicating that with the data available there is no difference in the vegetation characteristics of successful and unsuccessful nests.

In order to determine if the local landscape features affected productivity, we compared successful and unsuccessful nests and their distances to different field edges (road, tree line, woodlot, and agricultural land; Table 11). Field Sparrow nest success and distance to a road was the only comparison that was significantly different, with successful nests being closer to the road which is opposite from expected. When examining the relationship of landscape characteristics and nest success the results were similar to nest density. However, both Field Sparrow and Grasshopper Sparrow showed no relationship to any of the cover types or radii. Song Sparrow and Red-winged Blackbirds showed the same relationships except that Red-winged Blackbirds also had a trend with annual herbaceous cover at 2 km.

DISCUSSION

CREP fields are providing an important additional area for grassland birds to nest. In the Midwest, CRP fields have more nests and more species using them than row crops (Best et al. 1997). In our study, many more species used CREP fields than hayfields, but the total nest density (all species combined) was similar. Hayfields are much more like grassland than a row crop field and so would be more attractive to grassland birds (this was not addressed in this study). Hayfields were less successful than CREP fields, and

Table 11. Comparisons of successful and unsuccessful nests and their distance from the closest edge, road, tree line, woodlot or agriculture using a binary logistic regression for nests located in Southeast Pennsylvania during the summers of 2001 and 2002. Range of distances from edge in meters is in parenthesis for successful and unsuccessful nests.

Species	Edge	Number of nests		G score	P value
		Successful	Unsuccessful	(z score)	
EAME	Closest edge	2 (75-125)	5 (5-58)	1.00 (0.94)	0.317
FISP	Closest edge	26 (10-106)	27 (1-163)	7.08 (-2.45)	0.476
GRSP	Closest edge	5 (30-120)	9 (35-106)	0.01 (-0.07)	0.944
RWBL	Closest edge	85 (0-206)	140 (0-246)	0.37 (-0.61)	0.542
SOSP	Closest edge	13 (5-61)	18 (9-125)	0.10 (-0.32)	0.748
VESP	Closest edge	3 (28-71)	2 (57-92)	2.08 (-1.14)	0.150
EAME	Road	2 (125-200)	5 (5-185)	1.08 (0.87)	0.300
FISP	Road	26 (20-350)	27 (26-300)	7.08 (-2.45)	0.008**
GRSP	Road	2 (30-320)	6 (35-106)	2.21 (1.18)	1.38
RWBL	Road	43 (5-205)	90 (5-430)	0.60 (-0.75)	0.437
SOSP	Road	9 (34-250)	9 (20-195)	1.33 (1.09)	0.248
EAME	Tree line/woodlot	2 (82-175)	5 (39-180)	0.10 (0.31)	0.750
FISP	Tree line/woodlot	27 (10-105)	54 (5-190)	2.85 (-1.57)	0.091
GRSP	Tree line/woodlot	4 (80-120)	6 (37-111)	0.33 (0.56)	0.565
RWBL	Tree line/woodlot	72 (10-349)	127 (5-409)	2.26 (-1.46)	0.133
SOSP	Tree line/woodlot	7 (5-78)	12 (9-125)	0.23 (-0.47)	0.635
EAME	Woodlot	2 (82-175)	4 (58-180)	0.00 (0.04)	0.969
FISP	Woodlot	24 (10-130)	47 (5-200)	1.38 (-1.14)	0.240
GRSP	Woodlot	4 (89-220)	5 (45-175)	1.14 (0.99)	0.285
RWBL	Woodlot	30 (37-245)	68 (8-300)	1.48 (-1.19)	0.224
SOSP	Woodlot	6 (5-165)	8 (27-130)	0.48 (-0.68)	0.489
RWBL	Agriculture	21 (10-420)	39 (11-250)	0.32 (0.56)	0.574

this difference would have been more pronounced except for the late mowing of hayfields over the past two summers (June 26 – July 2, 2001; June 20 – June 27, 2002; pers. obs.) allowing many birds to raise broods before the first cutting. The hayfields used were also timothy or orchard grass hayfields and not alfalfa, which are cut much earlier and would have an even lower success rate for any birds nesting in them. No significant difference was found in the use of CREP and hayfields by obligate grassland birds, which may be a product of the small number of hayfields since there was only one hayfield with a nesting obligate grassland bird (we hope to address this problem with future field seasons). However, the only obligate grassland species found on the hayfields was the Bobolink, which has been shown to prefer hayfields to grasslands (Dale, Martin and Taylor 1997). This indicates that CREP fields are better habitats for most of the grassland obligate species than hayfields.

More large fields were found to have an obligate grassland bird nesting on them than either medium or small fields. This is not surprising since many grassland birds have been found to be area-sensitive (e.g. Herkert 1994, Vickery et al. 1994, Bollinger 1995, Winter and Faaborg 1999, Horn 2000). Because the large fields in this study are smaller than the minimum areas mentioned in other studies, it might indicate that these species choose the largest fields available. However, it was surprising to find that there was not a significant difference in bird density, nest density or success rate by field size, even for those species that are supposedly area-sensitive. This may be because in 2002 there were many fields that were extremely dense in clover and limited the birds that were able to use them (most only had Red-winged Blackbirds). Nor was there a significant difference in the success of a nest and its distance to an edge. Edge effects have been implicated in increased predation in other studies (Paton 1994); the only significant difference we found was in the opposite direction than expected with successful Field Sparrow nests closer to roads. The shape of most fields in this study is very irregular or long and rectangular, which minimizes the “core” area (the area away from any edge) and might explain the lack of difference between the field size categories; though we did not measure this (Helzer and Jelinski 1999). The overall nest success is similar to other studies for grassland species (Best et al. 1997, Winter and Faaborg 1999, McCoy et al. 2001, and Wentworth 2001), though the success rate for Grasshopper Sparrows is low (15%) which may indicate that they are not as successful in smaller fields than they are able to use in the midwest.

Very few vegetation characteristics showed any effect on the success of nests but for Field Sparrow and Red-winged Blackbird many of the variables were opposite (see Rottenberry and Wiens 1980 and Delisle and Savage 1997). This may be an explanation for why Field Sparrow and Red-winged Blackbird are not often found in the same field in high densities (pers. obs.).

Landscape characteristics showed little effect on nest density or nest success. Though there was a trend with some of the characteristics all the way out to 5 km. In other studies there was not any relationship found as far as 5 km (Bajema and Lima 2001) or where the radii were smaller in length (Ribic and Sample 2001).

Management implications

Our results suggest that larger fields should be targeted for CREP since more obligate grassland species use larger fields, though there is not a significant difference between field size and success or nesting density. Nest success does not seem to be affected by local landscape characteristics as evidenced by the lack of a significant difference in nesting success and a nest’s distance to different edges. From personal observations, most species prefer fields that are more heterogeneous, especially with clumps of vegetation and open areas around them. Most species, except Red-winged Blackbirds, avoid fields that are heavily seeded in clover. To avoid this, fields should have a lower seeding rate; especially of clover and some wild flower seed could be added to provide diversity and to provide more space between clumps of vegetation. We were unable to detect a difference between warm and cool-season grass because most of the warm-season grasses have not been established (further field seasons may answer this question, see King and Savidge 1995). Field Sparrows and Song Sparrows used woody vegetation for most of their nests, though Field Sparrows did use switchgrass commonly in fields in which it was present. Grasshopper Sparrows and Eastern Meadowlarks tended to nest under a clump of grass (either warm or cool-season) with litter available to cover the nest. Since Bobolink showed a preference (non-significant) for hayfields over CREP fields, we suggest that some fields, if possible, be managed similarly to hayfields - monoculture cool-season grass, and mowed (with litter removed) every year after August to avoid damaging nests, to provide more habitats for Bobolink.

In upcoming field seasons, we hope to expand the range of landscapes surrounding fields to determine if there are landscape effects on bird density, nest density and nest success. We also plan to increase the number of hayfields studied to increase the probability of detecting differences in hayfield and CREP use and productivity. In addition, we plan to have an increase in the number of nests that are monitored by infrared cameras to increase the likelihood that we will identify some of the predators on nests.

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Appendix 1- Common, scientific and abbreviations for bird species.

Species common name (*Scientific name*)	Abbreviation
Mallard (*Anas platyrhynchos)*	MALL
Northern Bobwhite (*Colinus virginianus)*	NOBO
Ring-necked Pheasant (*Phasianus colchicus)*	RNPH
Wild Turkey (*Meleagris gallopavo)*	WITU
American Robin (*Turdus migratorus*)	AMRO
Common Yellowthroat (*Geothlypis trichas)*	COYE
Northern Cardinal (*Cardinalis cardinalis)*	NOCA
Indigo Bunting (*Passerina cyanea)*	INBU
Dickcissel (*Spiza americana*)	DICK
Field Sparrow (*Spiza pusilla*)	FISP
Grasshopper Sparrow (*Ammodramus savannarum*)	GRSP
Savannah Sparrow (*Passerculus sandwichensis)*	SAVS
Vesper Sparrow (*Pooecetes gramineus*)	VESP
Song Sparrow (*Melospiza melodia)*	SOSP
Eastern Meadowlark (*Sturnella magna*)	EAME
Bobolink (*Dolichonyx oryzivorus*)	BOBO
Red-winged Blackbird (*Agelaius phoeniceus)*	RWBL
American Goldfinch (*Carduelis tristis)*	AMGO

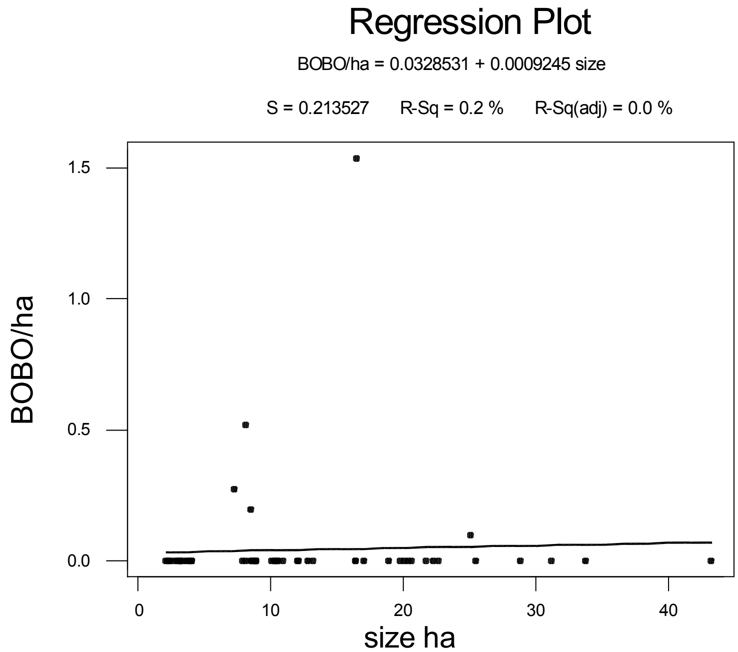
Appendix 2. Species, number of nests and the status of the nest for breeding birds during 2001 and 2002.

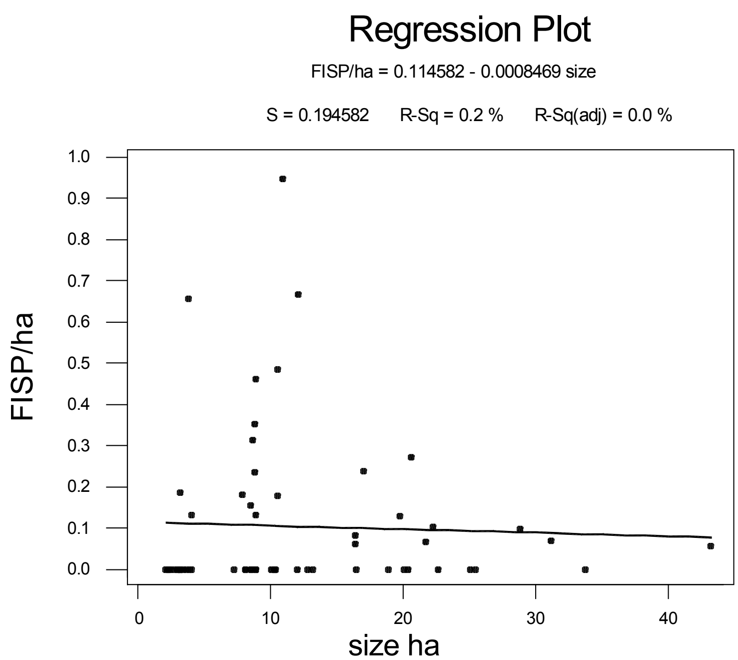
<10 acre	# Spp	Num nests	fledged	predated	active	mowed	abandoned	Other
Buck		0						
Byers	GRSP	1	1					
	INBU	1			1		1	
	WITU	1	1					
Totals		3	2		1		1	
Fetterman	RWBL	6	3	3				
Fletcher A	RWBL	1				1		
Hilkert Small	SOSP	1				1		
Lilley		0						
MP11	SOSP	1	1					
MP26	MALL	1		1				
	RWBL	5		5				
	FISP	2		1			1	
	SOSP	1		1				
Totals		9		8			1	
MP69	FISP	6	3	2				1
Morrison		0						
Robinson House	DICK	1	1					
	FISP	2	1	1				
	RWBL	1		1				
Totals		4	2	2				
Robinson Road		0						
Sandel		0						
Sidler Small	VESP	1	1					
Stahl Small	RWBL	3	1	1	1			
Zeisloft		0						
Totals	9 spp	35	12 (34.3)	16 (45.7)	2 (5.7)	2 (5.7)	2 (5.7)	1 (2.9)
20-30 acres								
Buck	FISP	13	9	3	1			
	WITU	2		1			1	
Totals		15	9	4	1		1	
Fisher	SOSP	3	1	2				
Fletcher B ‘01	RWBL	47	12	26		6	1	2
Fletcher B ‘02	BOBO	1					1	
	RWBL	10	3	3		2	2	
Totals		11	3	3		2	3	
Laudermilch	FISP	6	1	3		1	1	
	RWBL	2		2				
	SOSP	1	1					
Totals		9	2	5		1	1	
Moore		0						
MP53	FISP	2		2				
	MALL	1		1				
Totals		3		3				
Pharr B	RWBL	3	2		1			
	FISP	28	11	10	2		5	
	SOSP	1	1					

Totals		32	14	10	3		5	
Prison		0						
Rice	COYE	2	2					
	FISP	14	3	10	1			
	INBU	1		1				
	SOSP	1	1					
	WITU	1					1	
Totals		19	6	11	1		1	
Robbins '01	EAME	1		1				
	FISP	3		1				2
	RWBL	31	10	14	3		2	2
	SOSP	1		1				
Totals		36	10	17	3		2	4
Robbins '02	AMGO	1			1			
	FISP	2	2					
	RWBL	11	4	6			1	
	SOSP	15	7	4	4			
Totals		29	13	10	5		1	
Robinson Chick	FISP	3		3				
Robinson South	FISP	1	1					
Slabtown	FISP	1		1				
	SOSP	1	1					
Totals		2	1	1				
Wenner	FISP	1		1				
	RWBL	2	2					
	SOSP	1		1				
Totals		4	2	2				
Yeager	EAME	3	1	2				
	RWBL	47	9	31	6		1	
	SOSP	1		1				
Zimmerman		0						
Totals		51	10	34	6		1	
Totals	10 spp	265	84 (31.7)	131 (49.4)	19 (7.2)	9 (3.4)	15 (5.7)	6 (2.3)
40> acres								
495	RWBL	22	4	6		12		
Davies '01	AMRO	1			1			
	EAME	1		1				
	FISP	2	1	1				
	MALL	1		1				
	RWBL	21	7	13				1
Totals		26	8	16	1			1
Davies '02	FISP	4	3	1				
	INBU	1		1				
	MALL	1	1					
	RNPH	1		1				
	RWBL	27	13	10	2		2	
	SOSP	5	1	4				
	WITU	1	1					
Totals		40	19	17	2		2	
Hilkert Big	GRSP	6	1	3		2		
	INBU	2		1			1	
	SOSP	2	1	1				
	WITU	5	1	4				

Totals		15	3	9		2	1	
Inch	RWBL	4	2	2				
Klingler	GRSP	2		2				
	NOCA	1		1				
	RWBL	9	4	3	2			
Totals		12	4	6	2			
MP17	EAME	2	1	1				
	FISP	6	2	3	1			
	GRSP	3	2	1				
	RWBL	1		1				
	SOSP	2	1	1				
Totals		14	6	7	1			
Pfleegor	FISP	3	1	2				
	INBU	1	1					
	MALL	1	1					
	RWBL	15	6	6	1		2	
	SOSP	2	1	1				
	VESP	1	1					
Totals		23	11	9	1		2	
Pharr A	FISP	18	4	11	1		2	
	GRSP	3	1	2				
	INBU	2		1	1			
	RNPH	1		1				
	SAVS	2		2				
	SOSP	2	1	1				
	WITU	2		2				
Totals		30	6	20	2		2	
Sidler Big	FISP	1					1	
	GRSP	1		1				
	VESP	3	1	2				
Totals		5	1	3			1	
Spiegel	FISP	2	1				1	
	RWBL	9	4	2	1		2	
Totals		11	5	2	1		3	
Stahl Big	MALL	1	1					
	RWBL	48	16	23	2	1	4	2
Totals		49	17	23	2	1	4	2
Stamm	INBU	1	1					
	RWBL	2		2				
	WITU	1			1			
Totals		4	1	2	1			
Totals	13 spp	255	87 (34.1)	122 (47.8)	13 (5.1)	15 (5.9)	15 (5.9)	3 (1.2)
Grand Totals	17 spp	555	183 (33.0)	269 (48.5)	34 (6.1)	26 (4.7)	32 (5.8)	10 (1.8)

Appendix 3. Regression plots and equations for the comparisons of bird density and field size.

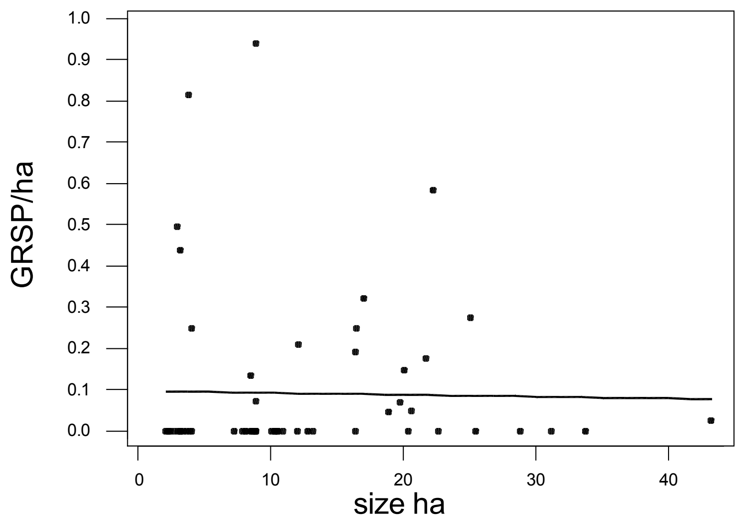




Regression Plot

GRSP/ha = 0.0968195 - 0.0004441 size

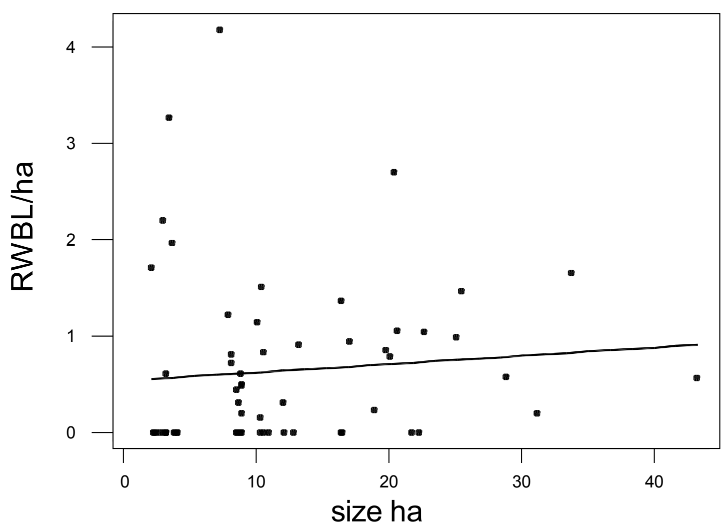
S = 0.198929 R-Sq = 0.0 % R-Sq(adj) = 0.0 %

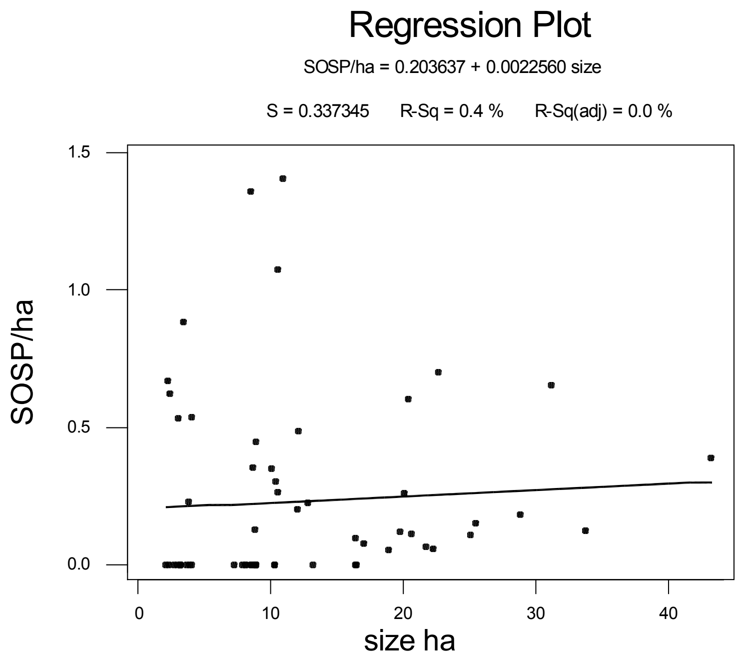


Regression Plot

RWBL/ha = 0.542434 + 0.0086428 size

S = 0.876716 R-Sq = 0.8 % R-Sq(adj) = 0.0 %




Regression Plot
SOSP/ha = 0.203637 + 0.0022560 size
S = 0.337345 R-Sq = 0.4 % R-Sq(adj) = 0.0 %
SOSP/ha
size ha
1.5
1.0
0.5
0.0
0
10
20
30
40

Appendix 4. Correlations for the vegetation measurements surrounding a species nest: Average coverage of forbs (forb), cool-season grass (c-g), warm-season grass (w-g), standing litter (s li), down litter (d li), woody vegetation (wood), bare ground (bare), average vegetation density (rob), average nest concealment (conc), litter depth (litter d), and height to bottom of nest (bottom).

Field Sparrow

	ave forb	ave c-g	ave w-g	ave s li	ave d li	ave wood	ave bare	ave rob
ave c-g	-0.378							
	0.000							
ave w-g	-0.342	-0.408						
	0.000	0.000						
ave s li	-0.368	-0.085	0.134					
	0.000	0.398	0.184					
ave d li	-0.405	-0.002	-0.034	-0.000				
	0.000	0.985	0.736	0.996				
ave wood	-0.356	0.261	-0.220	0.046	-0.210			
	0.000	0.009	0.028	0.651	0.036			
ave bare	-0.033	-0.188	-0.067	-0.063	0.138	-0.283		
	0.741	0.061	0.506	0.534	0.172	0.004		
ave rob	-0.171	-0.120	0.319	0.134	-0.145	0.127	-0.076	
	0.089	0.234	0.001	0.182	0.150	0.207	0.450	
ave conc	0.098	-0.174	0.096	0.085	-0.219	0.133	-0.226	0.164
	0.333	0.083	0.342	0.398	0.029	0.187	0.023	0.104
litter d	-0.104	0.032	0.010	-0.015	0.172	0.108	-0.189	0.017
	0.301	0.749	0.919	0.879	0.088	0.284	0.060	0.865
bottom	-0.214	0.017	0.049	0.315	-0.061	0.244	-0.091	0.565
	0.033	0.863	0.628	0.001	0.546	0.015	0.367	0.000

	ave conc	litter d
litter d	0.090	
	0.376	
bottom	0.151	0.118
	0.133	0.242

Grasshopper Sparrow

	ave forb	ave c-g	ave w-g	ave s-li	ave d-li	ave wood	ave bare	ave r 3m
ave c-g	-0.425							
	0.130							
ave w-g	0.227	-0.554						
	0.434	0.040						
ave s-li	-0.458	-0.356	-0.088					
	0.099	0.211	0.765					
ave d-li	-0.300	-0.295	0.268	0.047				
	0.297	0.306	0.355	0.873				
ave wood	-0.298	0.352	-0.251	-0.208	-0.080			
	0.300	0.218	0.386	0.475	0.787			
ave bare	-0.313	-0.303	-0.195	0.821	-0.260	-0.070		
	0.276	0.292	0.504	0.000	0.370	0.811		
ave r 3m	0.268	0.126	0.218	-0.277	-0.607	0.229	-0.013	
	0.354	0.667	0.453	0.338	0.021	0.431	0.964	
ave conc	0.410	-0.103	0.025	0.011	-0.639	-0.177	0.293	0.702
	0.146	0.726	0.932	0.970	0.014	0.545	0.309	0.005
Litter D	0.114	-0.483	0.803	-0.060	0.455	-0.252	-0.226	-0.063
	0.699	0.081	0.001	0.837	0.102	0.384	0.436	0.830

	ave conc
Litter D	-0.176
	0.548

Red-winged Blackbird

	ave forb	ave c-g	ave w-g	ave s-li	ave d-li	ave wood	ave bare	ave r 3m
ave c-g	-0.704							
	0.000							
ave w-g	-0.174	-0.237						
	0.004	0.000						
ave s-li	-0.213	-0.070	0.146					
	0.000	0.251	0.015					
ave d-li	-0.466	0.005	0.061	0.180				
	0.000	0.938	0.317	0.003				
ave wood	-0.223	-0.069	-0.049	0.121	0.205			
	0.000	0.255	0.423	0.044	0.001			
ave bare	-0.203	0.012	0.135	-0.049	0.112	-0.049		
	0.001	0.847	0.026	0.417	0.064	0.415		
ave r 3m	0.015	0.022	0.197	0.138	-0.018	-0.048	-0.146	
	0.807	0.721	0.001	0.022	0.762	0.427	0.016	
ave conc	-0.189	0.143	0.046	0.056	0.104	0.052	0.112	0.147
	0.002	0.017	0.449	0.357	0.085	0.387	0.063	0.015
Litter D	-0.301	0.016	0.167	0.187	0.408	0.213	0.109	0.017
	0.000	0.790	0.005	0.002	0.000	0.000	0.071	0.780
Bottom	0.031	-0.189	0.060	0.248	0.088	0.245	-0.230	0.369
	0.609	0.002	0.321	0.000	0.146	0.000	0.000	0.000

	ave conc	Litter D
Litter D	0.058	
	0.341	
Bottom	-0.376	0.121
	0.000	0.045

Song Sparrow

	ave forb	ave c-g	ave w-g	ave s-li	ave d-li	ave wood	ave bare	ave r 3m
ave c-g	-0.549							
	0.001							
ave w-g	-0.174	-0.396						
	0.340	0.025						
ave s-li	-0.469	0.073	0.172					
	0.007	0.693	0.347					
ave d-li	-0.524	0.226	0.088	-0.030				
	0.002	0.213	0.631	0.870				
ave wood	-0.599	0.198	-0.239	0.416	0.028			
	0.000	0.277	0.188	0.018	0.879			
ave bare	-0.067	-0.287	-0.054	0.082	-0.123	0.174		
	0.716	0.111	0.768	0.656	0.502	0.341		
ave r 3m	-0.248	-0.140	0.382	0.418	-0.015	0.177	-0.005	
	0.170	0.444	0.031	0.017	0.935	0.334	0.980	
ave conc	-0.235	0.232	-0.048	-0.343	0.172	0.095	0.187	0.074
	0.195	0.202	0.794	0.055	0.347	0.606	0.306	0.686
Litter D	-0.331	0.358	-0.081	-0.007	0.250	0.100	-0.005	-0.109
	0.065	0.044	0.660	0.970	0.167	0.585	0.976	0.551
Bottom	-0.486	0.179	-0.131	0.485	0.088	0.623	0.077	0.415
	0.005	0.326	0.476	0.005	0.632	0.000	0.676	0.018

	ave conc	Litter D
Litter D	0.159	
	0.384	
Bottom	-0.216	0.187
	0.234	0.306

Appendix 5. Percent landscape in forest, perrenial and annual herbaceous cover surrounding fields in southeast Pennsylvania in radius of 0.5, 1, 2, and 5 km.

					0.5 km radius			1.0 km radius			2 km radius			5 km radius		
type	county	FIELD	category	size ha	forest	perennial	annual	forest	perennial	annual	forest	perennial	annual	forest	perennial	annual
crep	MONTOUR	DAVIES	large	20.4	18.6	55.1	26.2	31.4	36.1	32.3	38.0	26.3	35.6	28.3	22.8	42.5
crep	UNION	STAHL BIG	large	25.5	21.6	19.4	57.9	44.5	21.1	33.7	40.9	22.8	31.5	49.1	23.1	24.9
crep	MONTOUR	PHARRA	large	24.3	30.2	38.6	31.1	35.1	37.3	27.5	46.6	27.2	26.1	41.5	27.7	30.6
crep	SNYDER	KLINGLER	large	17.0	30.2	24.1	45.5	39.8	23.2	36.9	33.9	19.8	45.8	31.7	21.9	43.7
Hay	MONTOUR	495	large	28.3	31.5	22.4	46.0	35.3	25.5	37.7	33.0	22.4	39.5	23.9	23.0	47.5
crep	UNION	STAMM	large	18.9	32.8	22.0	45.1	35.2	25.4	38.7	45.0	21.3	33.0	59.5	10.6	28.8
crep	SNYDER	SPIEGEL	large	20.6	32.9	19.8	39.8	29.0	23.0	24.9	28.4	22.4	19.1	46.2	11.8	21.4
crep	UNION	PFLEEGOR	large	22.7	33.9	39.3	8.9	34.8	45.4	13.8	43.3	33.7	18.9	55.4	21.8	20.5
crep	MONTOUR	MP17	large	24.3	40.0	55.7	4.1	49.9	28.4	19.6	35.9	31.1	25.7	26.5	24.2	43.9
crep	MONTOUR	SIDLER BIG	large	16.4	49.8	22.5	27.6	53.7	21.5	24.7	48.9	28.2	22.8	37.9	26.2	33.3
crep	MONTOUR	HILKERT	large	22.3	51.7	26.9	21.3	58.4	27.7	13.8	57.2	27.5	15.1	42.5	28.9	27.3
crep	SNYDER	INCH	large	20.1	63.4	0.2	36.3	62.5	16.5	20.7	50.3	17.7	31.3	36.2	16.0	45.1
crep	SNYDER	ROBINSON CHICK	medium	8.9	0.0	24.1	75.7	3.3	28.0	67.6	34.6	18.2	46.3	60.6	12.6	25.0
crep	SNYDER	ROBINSON S	medium	8.9	0.0	26.3	72.2	4.1	24.2	69.9	24.8	19.8	53.1	60.2	12.6	25.5
Hay	MONTOUR	FLETCHERB	medium	7.3	7.9	22.4	69.6	10.6	13.9	75.3	21.4	17.4	59.2	21.5	22.6	50.9
crep	MONTOUR	YEAGER	medium	12.1	12.3	52.2	35.4	29.4	37.3	33.2	43.3	33.9	22.5	52.3	23.8	23.3
crep	MONTOUR	PHARRB	medium	12.1	20.1	33.6	46.1	37.2	35.3	27.4	44.1	28.7	27.0	41.2	26.9	31.7
crep	UNION	MOORE	medium	12.0	20.6	3.9	67.9	29.4	15.5	48.0	45.1	12.2	40.0	55.9	12.2	29.2
crep	MONTOUR	HILKERT LITTLE	medium	8.9	25.4	37.4	37.1	28.3	45.0	25.8	29.5	43.1	26.6	61.0	21.7	12.2
crep	MONTOUR	MP53	medium	10.1	30.7	44.9	21.0	32.3	30.2	29.3	40.8	28.1	24.6	25.2	23.1	45.7
crep	UNION	WENNER	medium	8.8	34.8	16.7	43.7	13.3	17.5	61.4	12.2	18.2	65.0	23.6	21.7	51.6
crep	SNYDER	LAUDERMILCH	medium	8.7	45.1	19.6	35.1	47.4	18.4	32.3	44.0	17.3	33.9	51.6	18.8	27.0
crep	MONTOUR	ROBBINS	medium	10.5	45.2	20.3	34.3	48.2	16.3	35.3	64.7	15.9	19.1	68.2	15.6	15.6
Hay	MONTOUR	SLABTOWN	medium	10.5	49.2	40.7	10.0	58.9	26.5	14.5	71.1	15.9	12.5	76.2	15.3	7.5
crep	UNION	FISHER	medium	8.5	52.9	37.4	9.6	53.8	33.6	11.6	42.4	37.5	18.4	39.9	29.4	29.3
crep	MONTOUR	BUCK	medium	12.1	66.6	27.9	5.4	52.7	28.7	18.4	42.6	29.3	28.0	35.4	27.8	35.3
Hay	SNYDER	PRISON	medium	10.3	76.6	7.7	15.6	48.2	11.1	37.6	29.1	13.7	50.5	29.7	19.1	48.8
crep	MONTOUR	RICE	medium	10.5	77.2	15.6	7.2	64.1	17.7	18.0	61.3	17.4	20.3	66.4	17.5	15.6

Hay	UNION	ZIMMERMAN	medium	8.5	92.2	7.8	0.0	86.5	6.9	6.3	80.0	10.4	8.5	69.5	15.1	12.7
crep	SNYDER	ROBINSON HOUSE	small	3.2	0.0	17.4	82.5	2.8	27.6	69.2	34.2	18.2	46.6	59.8	12.7	25.6
crep	SNYDER	ROBINSON ROAD	small	3.2	0.0	9.1	90.9	0.2	28.0	70.8	26.7	19.6	52.5	58.8	13.0	26.3
crep	MONTOUR	FETTERMAN	small	3.4	6.5	14.7	78.6	36.4	14.1	49.4	48.8	17.8	33.2	47.4	20.7	28.6
Hay	MONTOUR	FLETCHERA	small	4.1	7.5	15.3	77.2	11.1	15.9	72.8	21.8	17.4	59.0	21.7	22.5	50.8
crep	MONTOUR	SANDEL	small	2.4	10.1	40.1	49.6	26.7	32.5	40.6	44.3	26.8	28.8	48.4	28.3	23.0
crep	SNYDER	BYERS	small	3.8	27.2	16.0	52.5	25.5	12.3	58.5	25.8	25.7	44.4	34.3	25.2	38.8
Hay	MONTOUR	MORRISON	small	3.2	33.5	29.9	36.5	49.3	25.2	25.4	58.9	21.7	18.7	63.9	16.0	19.1
crep	UNION	STAHL SMALL	small	3.0	34.2	25.1	40.5	51.0	15.2	33.4	47.3	21.8	26.3	51.4	22.3	23.6
crep	MONTOUR	MP26	small	4.5	34.5	40.0	24.7	35.9	25.6	33.4	42.5	28.3	22.1	25.7	23.7	45.2
crep	MONTOUR	MP69	small	3.2	43.4	27.7	11.5	39.1	21.2	24.6	31.6	25.3	37.6	23.5	21.7	48.6
crep	MONTOUR	MP11	small	4.1	43.9	50.1	5.8	43.2	29.0	25.9	36.0	32.6	24.0	26.8	24.1	43.9
crep	MONTOUR	ZEISLOFT	small	2.8	49.2	24.7	26.0	33.2	24.7	42.0	35.5	21.9	42.4	39.1	25.7	34.8
crep	MONTOUR	SIDLER LITTLE	small	4.1	72.9	20.2	6.6	87.5	9.0	1.9	95.5	3.0	0.9	93.2	1.9	0.7